

Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

AMENDMENT

In the Claims

Please amend the claims as follows, without prejudice:

Please delete claims 35 and 36.

- B1
1. (Twice Amended) A method for modifying a voxel-based virtual object in a haptic virtual environment, comprising:
 - determining a virtual tool comprising a plurality of discrete points for use by the user in the haptic virtual environment;
 - selecting a modification mode that modifies a voxel value representative of the voxel-based virtual object;
 - sensing a location of a user in real space;
 - determining locations of the plurality of discrete points of the virtual tool relative to a location of the voxel-based virtual object;
 - calculating an interaction force between the virtual tool and the voxel-based virtual object based on the locations of the plurality of discrete points of the virtual tool and the location of the voxel-based virtual object;
 - producing a modified voxel-based virtual object by modifying the voxel-based virtual object based on the modification mode, the locations of the plurality of discrete points of the virtual tool, and the location of the voxel-based virtual object; and
 - outputting the modified voxel-based virtual object.

- B2
2. (Amended) The method of claim 1, further comprising the steps of
 - determining a virtual surface for the voxel-based virtual object; and
 - determining a position and an orientation of the virtual tool by determining the locations of the plurality of discrete points relative to the virtual surface of the voxel-based virtual object.

Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

B2
cont

3. (Amended) The method of claim 2, wherein the step of determining the virtual surface comprises determining a virtual isosurface for the voxel-based virtual object.

4. (Amended) The method of claim 1, wherein the voxel-based virtual object is a volumetric representation.

B3

6. (Twice Amended) The method of claim 1, wherein the step of selecting a modification mode comprises selecting at least one of a material removal mode, a material addition mode, a smoothing mode, a mirroring mode, and a 3-D sketch mode.

B4

9. (Amended) The method of claim 1, further comprising the step of exporting the modified voxel-based virtual object.

B5

10. (Twice Amended) A system for modifying a voxel-based virtual object by a user in a haptic virtual environment, the system comprising:

a virtual tool comprising a plurality of discrete points for use by the user in the haptic virtual environment, wherein the user selects a modification mode that modifies a voxel value representative of the voxel-based virtual object;

a haptic interface device, wherein the haptic interface device senses a location of the user in real space; and

a modeling application in communication with the haptic interface device, the voxel-based virtual object, and the virtual tool, wherein the modeling application determines locations of the plurality of discrete points of the virtual tool relative to a location of the voxel-based virtual object; calculates an interaction force between the virtual tool and the voxel-based virtual object based on the locations of the plurality of discrete points of the virtual tool and the location of the voxel-based virtual object; produces a modified voxel-based virtual object by modifying the voxel-based virtual object based on the modification mode, the locations of the plurality of discrete points of the virtual tool, and the location of the voxel-based virtual object; and outputs the modified voxel-based virtual object.

B6
cont

11. (Amended) The system of claim 10, further comprising

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Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

B7C

the voxel-based virtual object comprising a virtual surface; and
the virtual tool comprising a position and an orientation, wherein the modeling application determines the position of the virtual tool and the orientation of the virtual tool by determining the locations of the plurality of discrete points relative to the virtual surface of the voxel-based virtual object.

B7

12. (Amended) The system of claim 11, wherein the virtual surface of the voxel-based virtual object is a virtual isosurface.

13. (Amended) The system of claim 10, wherein the voxel-based virtual object is a volumetric representation.

B8

18. (Amended) The system of claim 10, wherein the modeling application exports the modified voxel-based virtual object.

B9

24. (Twice Amended) The method of claim 19, further comprising the steps of selecting a modification mode that modifies a voxel value representative of the voxel-based virtual object, and modifying the voxel-based virtual object in response to the modification mode and the position of the virtual tool.

B10

32. (Twice Amended) The system of claim 27, further comprising a modification mode that modifies a voxel value representative of the voxel-based virtual object, and the modeling application modifies the voxel-based virtual object in response to the modification mode and the position of the virtual tool.

Applicant: Shih et al.
U.S. Serial No. 09/347,637
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RESPONSE

Prior to entry of this Amendment and Response, claims 1-36 are pending in the Application. Claims 1-36 stand rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,191,796 to Tarr (hereinafter "Tarr").

Applicants have amended independent claims 1 and 10 to recite a "voxel-based virtual object" by incorporating the language of dependent claims 35 and 36, respectively, in the independent claims. Applicants have further amended claims 1, 10, 24, and 32 to recite "a modification mode that modifies a voxel value representative of the voxel-based virtual object." Applicants have amended the terminology of dependent claims 2, 3, 4, 6, and 9 to conform to that of amended independent claim 1. Applicants have also amended the terminology of dependent claims 11, 12, 13, and 18 to conform to that of amended independent claim 10. Applicants have canceled, without prejudice, dependent claims 35 and 36. Support for the amendments may be found throughout the Specification and Drawings and particularly at page 19, lines 22-26; page 20, lines 15-22,; page 22, line 20, through page 21, line 17; page 29, line 1, through page 34, line 26; and page 60, line 16, through page 77, line 17. By way of example, and for the convenience of the Examiner, with regard to the claim language "a modification mode that modifies a voxel value representative of the voxel-based virtual object," Applicants respectfully point out that the Specification at page 60, lines 23-25, recites "Modifications to the isosurface 86 are made indirectly, by modification of the voxel density values, based on the virtual tool 28 location relative to the isosurface 86." Many other embodiments are disclosed in the Specification. No new matter has been added by these amendments. Following entry of the present amendments, claims 1-34 are pending in the Application.

Applicants wish to thank Examiner Santiago for his helpful suggestions and recommendations during a telephonic interview that took place on August 1, 2002. In addition to Examiner Santiago, the participants in the interview were Inventor Thomas H. Massie and the undersigned attorney for Applicants. During the telephonic interview there was a discussion of definitions of terminology that appear in Tarr. To the extent that Tarr is relied upon as a prior art

Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

reference, terms defined by Tarr in a particular way should be applied using the meaning given to them by Tarr, rather than using another meaning. In particular, the following passages in Tarr were discussed:

Column 16, lines 13-15: As mentioned above, in one embodiment, the virtual surface is defined as a mesh and the virtual tool as the volume.

Column 4, lines 36-39: As used herein, a "haptic interactive representation" is defined as a computer generated virtual environment which can be explored by a user through the sense of touch.

Column 4, lines 39-41: As used herein, "virtual object" is defined as the representation of a real world object in the haptic interactive representation.

Column 7, lines 9-11: As used herein, "virtual surface" is defined as the representation of a real world surface in the haptic interactive representation.

Column 5, lines 30-36: In the embodiments described below, the virtual [sic, virtual] plastically-deformable surfaces and the virtual visco-elastically deformable surfaces are composed of a triangular mesh. In other embodiments, the virtual surfaces may be composed of other polygonal meshes or may be defined by algebraic equations.

Column 5, lines 36-37: In general, the virtual surfaces may be combined [sic, combined] to form a virtual object having a volume.

The discussion touched on the distinction between a three-dimensional object, such as a sphere, and a two-dimensional object, such as the surface of the sphere. The surface of a sphere has no thickness and a point on the surface can be uniquely described using only two coordinates, since the distance from every point on the surface of the sphere to the center of the sphere is a constant, namely, the radius of the sphere. By way of example, taking the Earth as a sphere, the location of Washington, DC is uniquely defined by its latitude and longitude. Applicants respectfully submit that this paper is consistent with the discussion that took place in the telephonic interview.

Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Rejection of Claims 1-36 under 35 U.S.C. §102(e)

Claims 1-36 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Tarr. Claims 35 and 36 have been canceled without prejudice, and so their rejection is moot. Independent claims 1, 10, 19, and 27, as presently amended, recite "voxel-based virtual object" as a claim limitation. Dependent claims 2-9, 11-18, 20-26, and 28-34 depend respectively from independent claims 1, 10, 19, and 27 and each includes the limitations of the independent claim from which it depends. Accordingly, each of claims 1-34 pending in the application includes "voxel-based virtual object" as a claim limitation. Independent claims 1 and 10, dependent claims 2-9 depending from claim 1, dependent claims 11-18 depending from claim 10, and claims 24 and 32 also include as a limitation "a modification mode that modifies a voxel value representative of the voxel-based virtual object."

Tarr discloses surface modifications of virtual objects, including plastic and visco-elastic deformations of virtual surfaces. For example, see the Abstract of Tarr, Figure 1B of Tarr, and the disclosure of Tarr at column 2, lines 2-33, and column 5, line 11 through column 10, line 43. Tarr does not appear to expressly disclose a virtual object that is represented other than as one or more surfaces.

Tarr uses the term "voxel" in three locations of the disclosure, namely, column 14, lines 4-32; column 16, line 30, through column 17, line 8; and column 19, lines 17-53. In each instance, Tarr uses the term "voxel" with regard to the three dimensional nature of a virtual tool having a volume. Tarr discloses the use of a tool at column 5, lines 37-46:

Also, in the embodiments described below, the user interacts with the virtual surfaces in the virtual environment through a volume referred to as a tool. The user may select any volume shape for the tool. The shape of the volume or tool determines how the virtual surface is deformed. The tool may be represented as a series of discrete points in vial [sic] space which form the volumetric shape of the tool. FIG. 1D shows an example of a virtual surface 32 and a "tool" 56. The tool represents the user in the virtual world. (emphasis added)

Applicant: Shih et al.
U.S. Serial No. 09/347,637
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Since Tarr states that the tool represents the user, and the tool is the medium by which the user interacts with the virtual surfaces in the virtual object, it is inappropriate to describe the tool as a virtual object.

Tarr does not describe the virtual surface, a two dimensional construct, in terms of voxels, which are a three dimensional construct. As recited above, Tarr states that "the virtual surfaces may be combines [sic, combined] to form a virtual object having a volume," but Tarr does not describe the volume beyond this description of its surface. Therefore, Tarr fails to expressly disclose a voxel-based virtual object *per se*, and certainly fails to disclose the interaction of a voxel-based virtual object with a virtual tool.

Furthermore, Tarr fails to disclose "a modification mode that modifies a voxel value representative of the voxel-based virtual object." Tarr does not expressly disclose modifications of a virtual object other than as modifications of a two dimensional virtual surface. For example, Tarr does not disclose adding material to or subtracting material from a virtual object.

Accordingly, Applicants respectfully submit that independent claims 1, 10, 19 and 27 as presently amended are patentable over Tarr, because Tarr fails to disclose every limitation of independent claims 1, 10, 19, and 27. Since each dependent claim includes all of the limitations of every claim from which it depends, Applicants respectfully submit that dependent claims 2-9, 11-18, 20-26, and 28-34 are patentable as depending from allowable independent claims 1, 10, 19, and 27, respectively.

In view of the forgoing, Applicants respectfully request that the rejection of claims 1-34 under 35 U.S.C. §102(e) be reconsidered and withdrawn. Applicants respectfully submit that claims 1-34 are now in condition for allowance.